

Transportation and Fuel Technologies Performance Analysis Methodology

1998 Update

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Principal Topics

- **Technologies**
- Attributes, assumptions and inputs
- Methodology
- Market penetration forecasts
- Benefits Predictions
- Analysis of Results

Technologies Addressed

- TECHNOLOGY UTILIZATION: CNG
- BIOFUELS: Ethanol
- ADVANCED AUTOMOTIVE TECHNOLOGIES:
 - Electric Vehicle R&D:
 - Fuel Cell R&D: Ethanol Reformer
 - Hybrid Vehicle R&D: 3X Efficiency, Gasoline
 - Light Duty Engine R&D: Advanced Diesel
- ADVANCED HEAVY VEHICLE TECHNOLOGIES:
 - Classes 7 & 8
 - Classes 3 - 6
 - Classes 1 and 2 for Dieselization
- MATERIALS TECHNOLOGIES:
 - Propulsion System Materials: Ceramics
 - Light-duty Vehicle Materials

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Vehicle Classes

- **FOUR LIGHT VEHICLE CLASSES**

- Small cars

- Large cars

- Passenger trucks

- Cargo trucks

- **HEAVY DUTY VEHICLES**

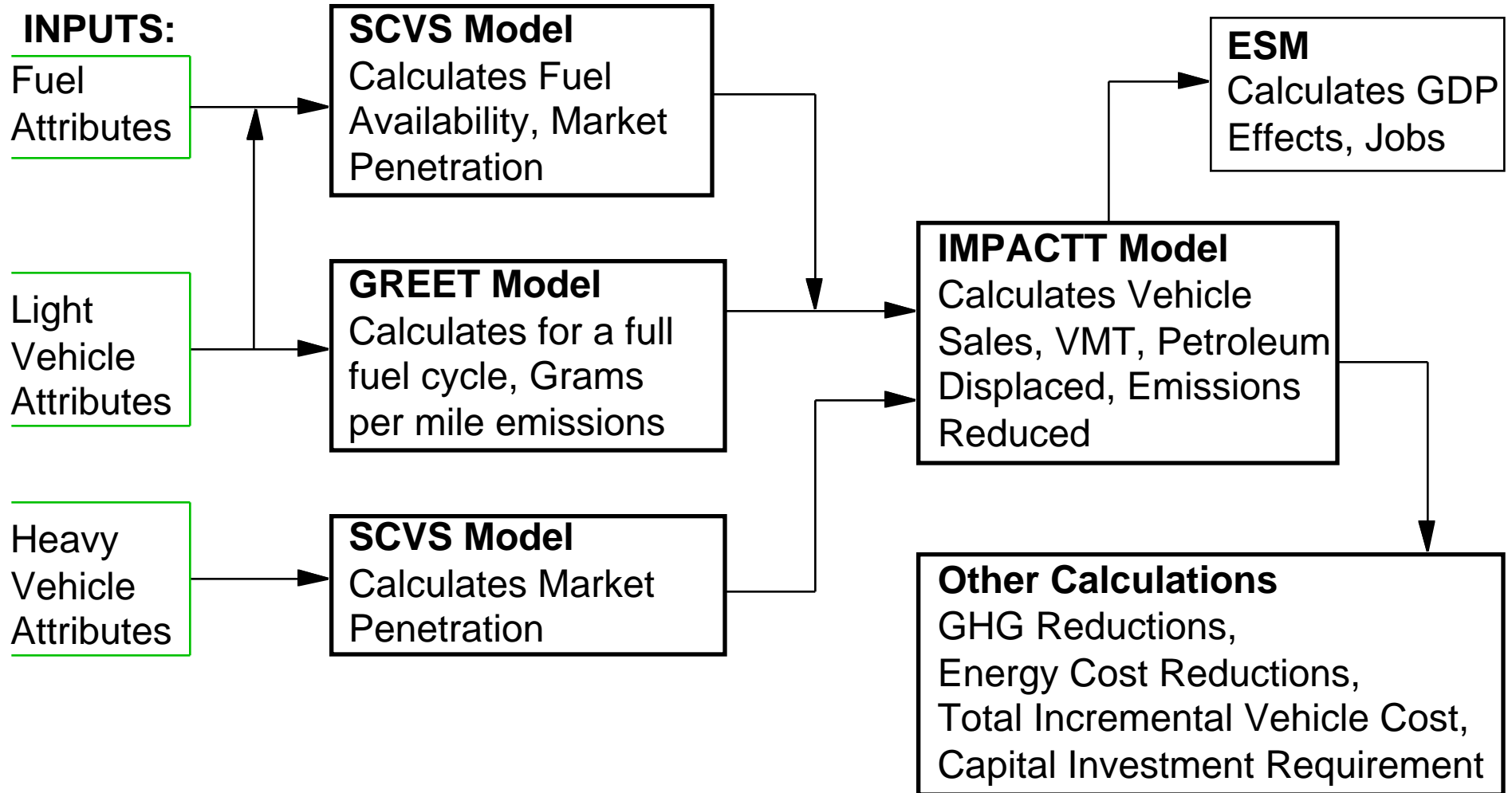
Technology Characteristics - Large Car

TECHNOLOGY	YEAR OF MATURITY	VEHICLE COST RATIO, \$	FUEL ECONOMY RATIO, mpg	RELATIVE RANGE, miles
CONVENTIONAL	N/A	\$22,000	21.9	350
ADV. DIESEL	2012	1.05	1.3	1.2
HYBRID	2015	1.2	2.5	1.0
FUEL CELL	2013	1.25	2.5	1.0
NATURAL GAS	2002	1.07	1.0	0.75
DED. ETHANOL	2005	1.0	1.08	1

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Modeling Process



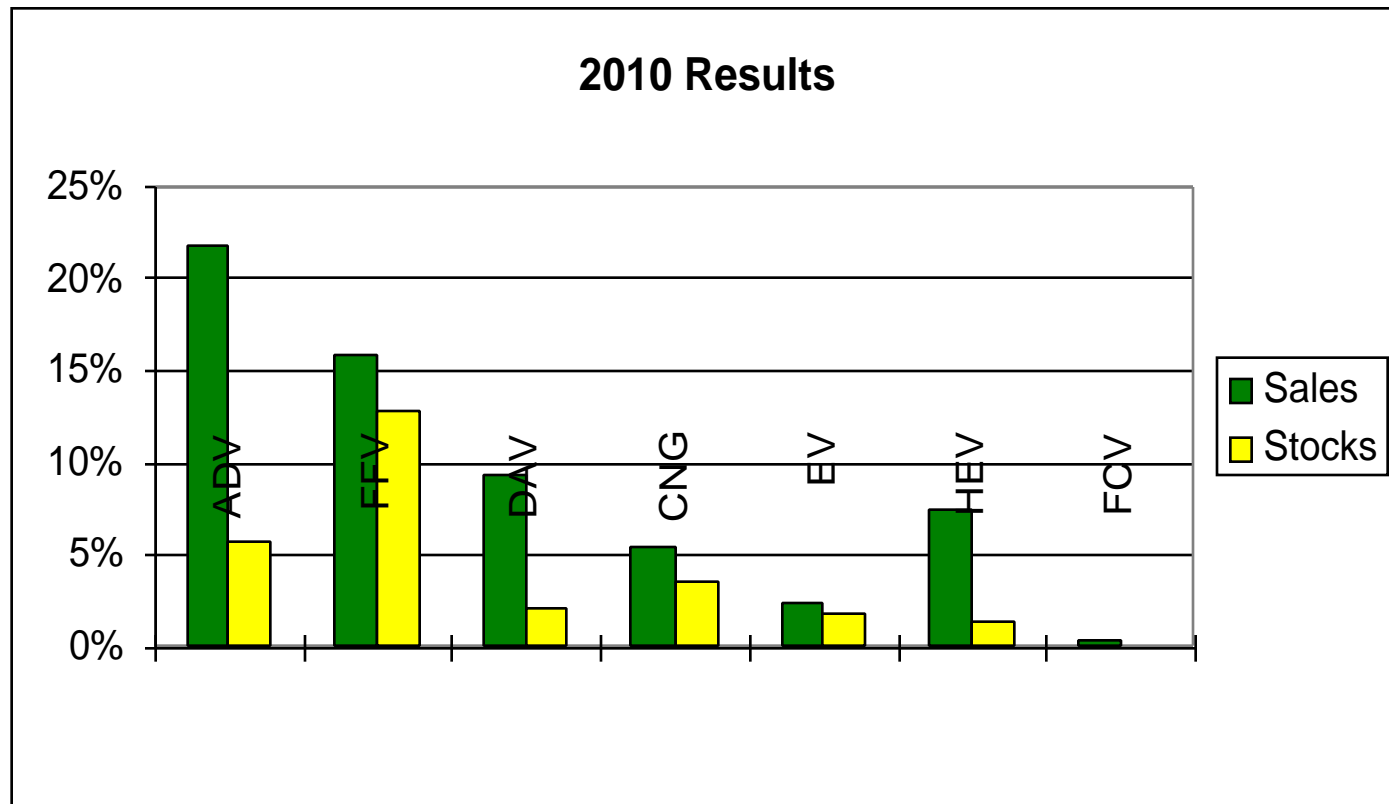
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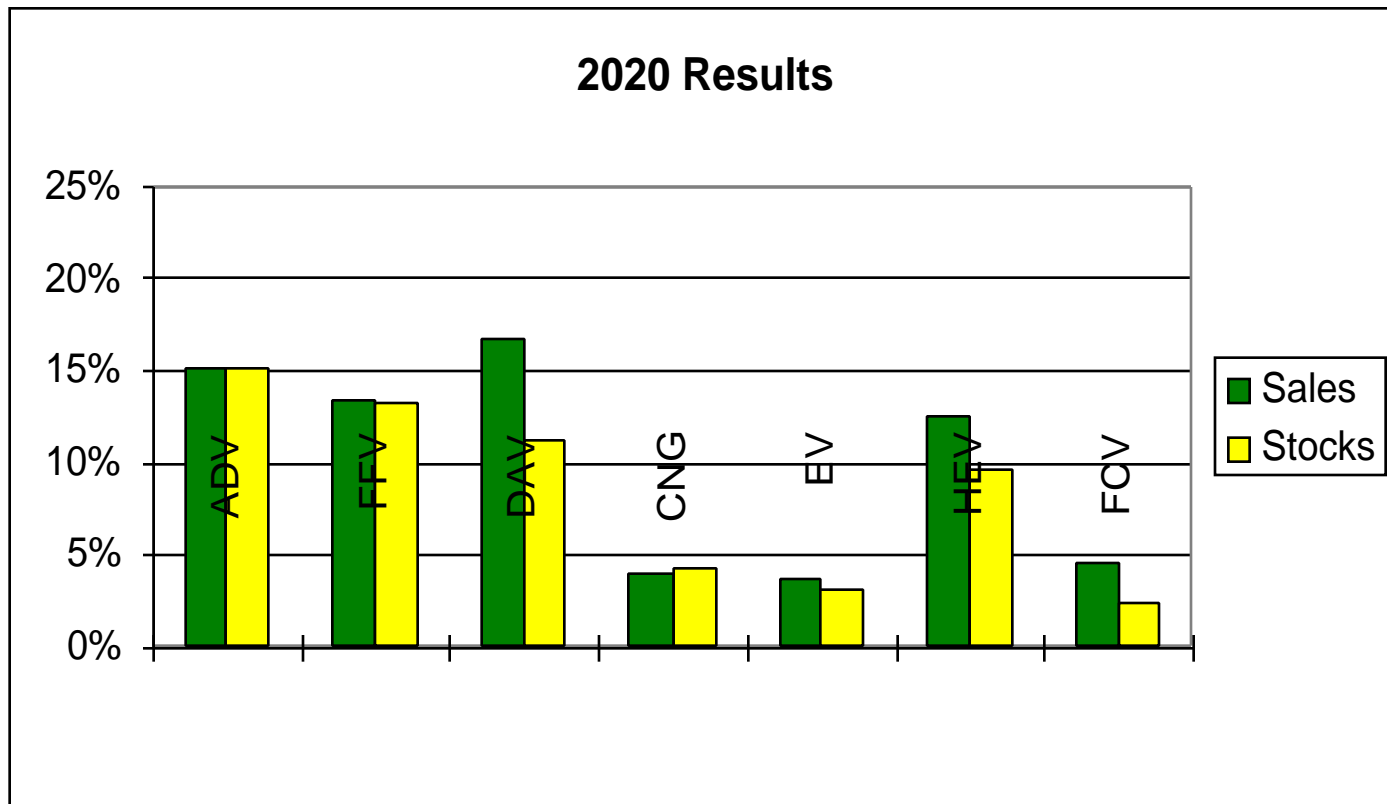
Biomass Fuel Use

YEAR	2010	2020	COMMENTS
ETHANOL USE, Gal. X 10 ⁹	10.3	27.4	
SUPPLY CONSTRAINT, Gal X 10 ⁹	12	20	1/2 USED IN BLENDS.
FUEL AVAILABILITY, % of Stations	27.6%	66.7%	

Light Vehicle Penetration



Light Vehicle Penetration



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- **Estimated Benefits**
- Analysis of Results

Estimated Impacts

- Energy Use: Reductions in Primary Energy and Oil Use
- Emissions: Criteria and Greenhouse Gas
- Economic: GDP and Jobs

Energy Displaced

TECHNOLOGY	PRIMARY OIL, mmb/d	
	2010	2020
Tech. Utilization	0.25	0.25
Biofuels	0.4	1.12
Adv. Auto Technologies	0.16	0.66
Heavy Vehicles	0.08	0.19
Total	0.89	2.22
Baseline	12.95	14.31
Percent Reduction	6.9%	15.5%

Carbon Emission Reduction

TECHNOLOGY	CARBON REDUCTIONS, MMTons	
	2010	2020
Technology Utilization	2.56	2.57
Biofuels	16.13	42.72
Adv. Auto Technologies	3.32	23.54
Heavy Vehicles	2.93	7.51
Total	24.94	76.34
Baseline	552.4	591.0
Percent Reduction	4.5%	12.9%

Values are in units of CO² Carbon Equivalents

Source: DOE/EIA 0573; Table 6, p.15

Economic Impacts

TECHNOLOGY	Net. Increase in GDP, \$ X 10⁹	
	2010	2020
Tech. Utilization	3.7	8.7
Biofuels	4.4	9.6
Adv. Auto Technologies	15.2	41.1
Total	23.3	59.5
Baseline	7,485.0	9,145.0
Percent Reduction	0.31%	0.65%

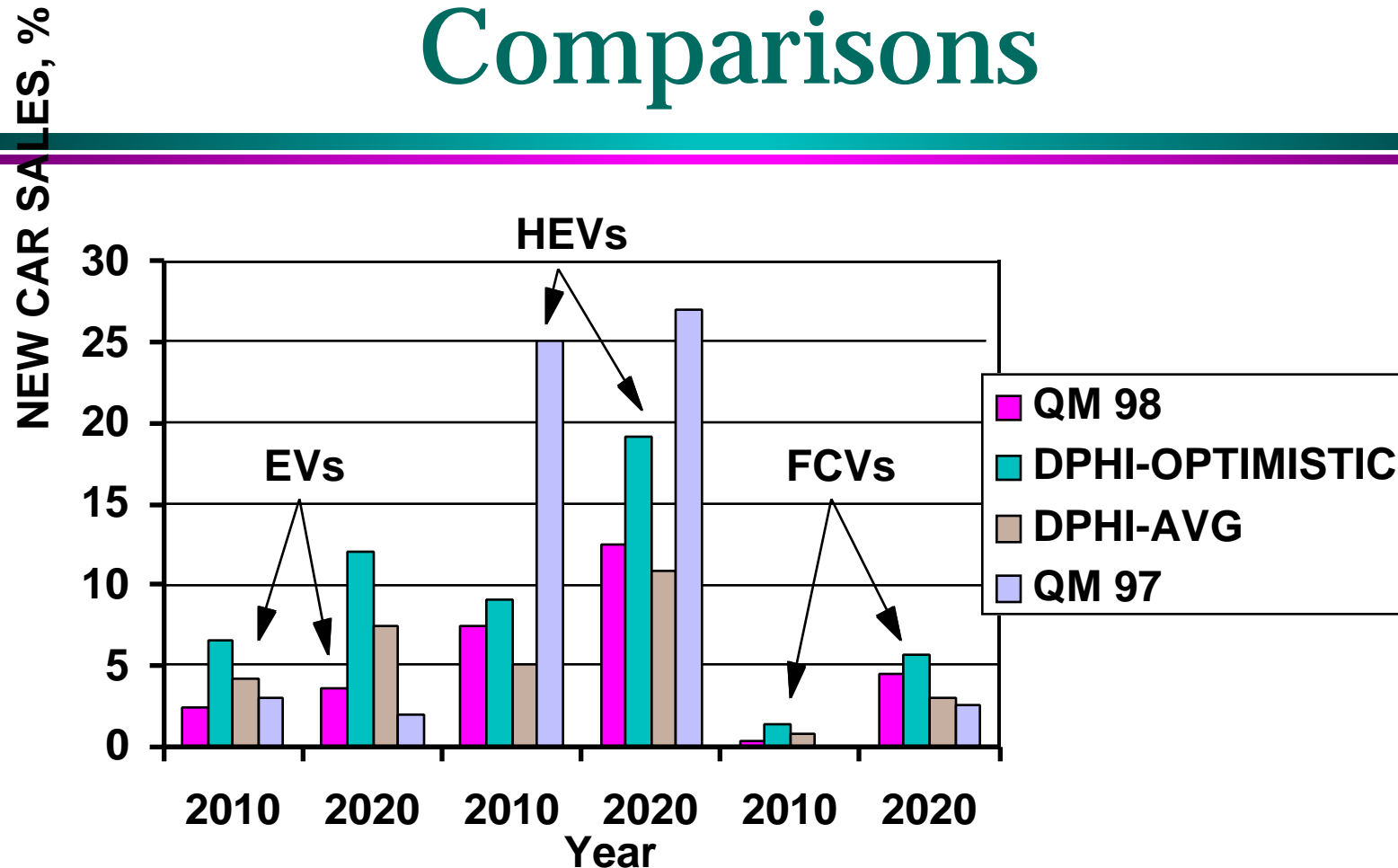
Benefit-Cost Cumulative Table (\$ Billions)

YEAR	2010	2020
<i>BUDGET COSTS</i>	\$2.0	\$2.0
<i>BENEFITS</i>	\$63.9	\$385.1
Energy Savings	\$25.6	\$191.3
Oil Security (\$/bbl)	\$1.5	\$7.6
Fuel Price Changes	\$7.2	\$12.9
Pollution Reduction	\$13.3	\$87.0
Incremental Costs	(\$104.3)	(\$350.7)
GDP Benefits	\$120.6	\$436.9
<i>Benefit to Cost Ratio</i>	32.0	192.6

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Market Penetration Estimate Comparisons



Note: Delphi Values from Argonne National Laboratory (Ng, et. al., SAE 8/96)

Credibility of Results

- **METHODOLOGY**
 - Logit Model
 - National survey data
- **TECHNOLOGY CHARACTERISTICS**
 - Peer reviewed - 3 years
- **MARKET PENETRATION ESTIMATES**
 - Vehicle class considerations
 - Staggered, “S” curve introductions

Summary

- THREE ROUNDS OF “QUALITY METRICS” TECHNOLOGY EVALUATIONS

Attributes are based on program goals-
subjected to external review and comparison

Light vehicle methodology is complex and
evolving

Results broadly consistent with historical
cases: e.g. rail engines, light vehicle front
wheel drive, fuel injection.

- “SCENARIO” ANALYSIS IN PROGRESS

QM 98 Vehicle Attribute Life Cycle Cost Implications - 2020 (Business Autos)

TECHNOLOGY	VEHICLE PURCHASE COST, \$	PRESENT WORTH (13 YRS.), \$	PRESENT WORTH (13 YRS.), \$	NET PRESENT WORTH, \$	TOTAL ANNUAL OPER. COST, \$	ANNUAL OPER. COST DIFF., \$ (NOTE 1)	INCREMENTAL CAPITAL COST, \$ (NOTE 2)	PAYBACK PERIOD, YRS.	NPW RANK
GASOLINE ICE	30,070	3,200	3,530	36,800	2,621	0	0	N/A	2
ELECTRIC	34,581	1,393	2,916	38,890	1,678	943	(4,511)	5	4
CNG	32,175	2,292	3,212	37,679	2,143	477	(2,105)	4	3
ETHANOL	30,070	2,963	3,412	36,444	2,482	138	0	0	1

NOTE 1: COSTS THAT ARE LOWER THAN CONVENTIONAL HAVE POSITIVE SIGN

NOTE 2: COSTS THAT ARE HIGHER THAN CONVENTIONAL HAVE NEGATIVE SIGN